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SEMI-ANNUAL PROGRESS REPORT FOR NASA GRANT

NGR 31-001-197 TO PRINCETON UNIVERSITY

April 1, 1973 - October 1, 1973

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TECHNICAL DISCUSSION

During the present reporting period progress has been made in the following areas:

General Purpose Computer Program

A flutter program has been developed for a rectangular, orthotropic panel on point supports of finite stiffness as well as edge, line supports of finite stiffness. To check the flutter program, per se, simple piston theory aerodynamics were used. The boundary layer aerodynamic program has now been modified to accept free-free beam modes so that these aerodynamics may be used in the flutter program. RSI panels, representative of the proposed Space Shuttle design, can be analyzed with these programs. The principal investigator has provided operational versions to Ames during his recent stay there.

Lifting Surface Theory with Boundary Layer

Major progress has been made in this area. The incompressible, steady, two-dimensional case has been completely solved. The three-dimensional case appears to be a straightforward extension. Preliminary work is beginning on unsteady effects.

Typical of our results to date are those shown in Fig. 1 and 2. Fig. 1 gives the effect of boundary layer thickness to chord ratio, δ/c, on lift curve slope, c_L, and center of pressure, $\frac{x_{cp}}{c}$. The latter is unaffected. However, recall we are assuming the boundary layer thickness is constant over the airfoil. What this means is that to obtain the effect of boundary layer

thickness on x_{cp} we must allow δ to vary with streamwise position, x. In Fig. 2 representative pressure distributions are shown.

It would be desirable to begin work on compressibility effects and variation of boundary layer thickness with streamwise distance. However current manpower and funding levels do not permit this.

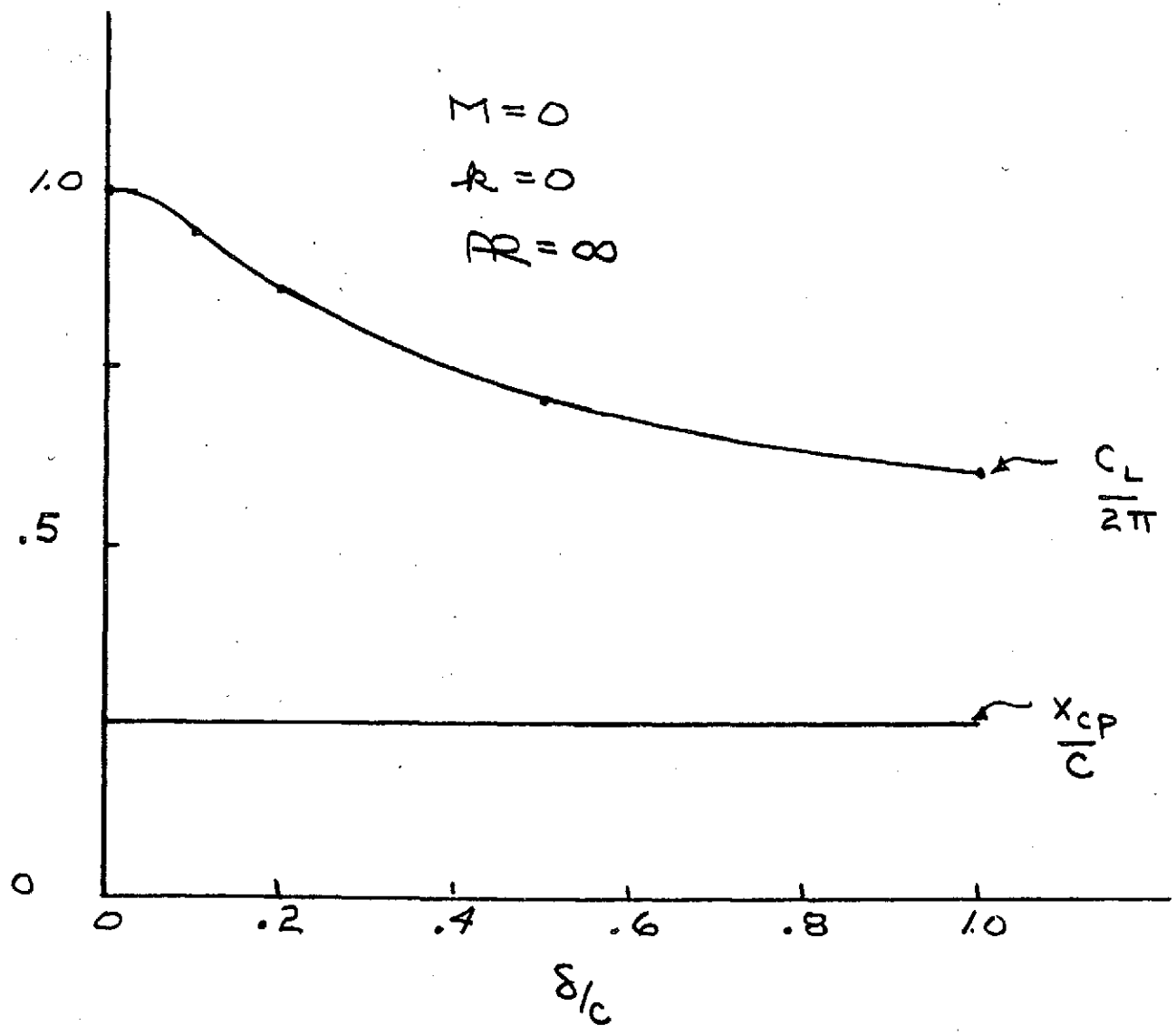
BUDGETARY DISCUSSION

One graduate student and one research staff member are presently working on this program in addition to the principal investigator. In order to exploit fully on a timely basis our success on the lifting surface problem, we shall seek additional funding.

REFERENCES

1. Dowell, E. H., "Generalized Aerodynamic Forces on a Flexible Plate Undergoing Transient Motion in a Shear Flow," AIAA Journal, Vol. 9, No. 5, pp. 834-841, May 1971.

2. Ventres, C. S., "Transient Panel Motion in a Shear Flow," Princeton University AMS Report No. 1062, August 1972.



EFFECT OF BOUNDARY LAYER THICKNESS ON LIFT CURVE SLOPE AND CENTER OF PRESSURE

FIG. 1

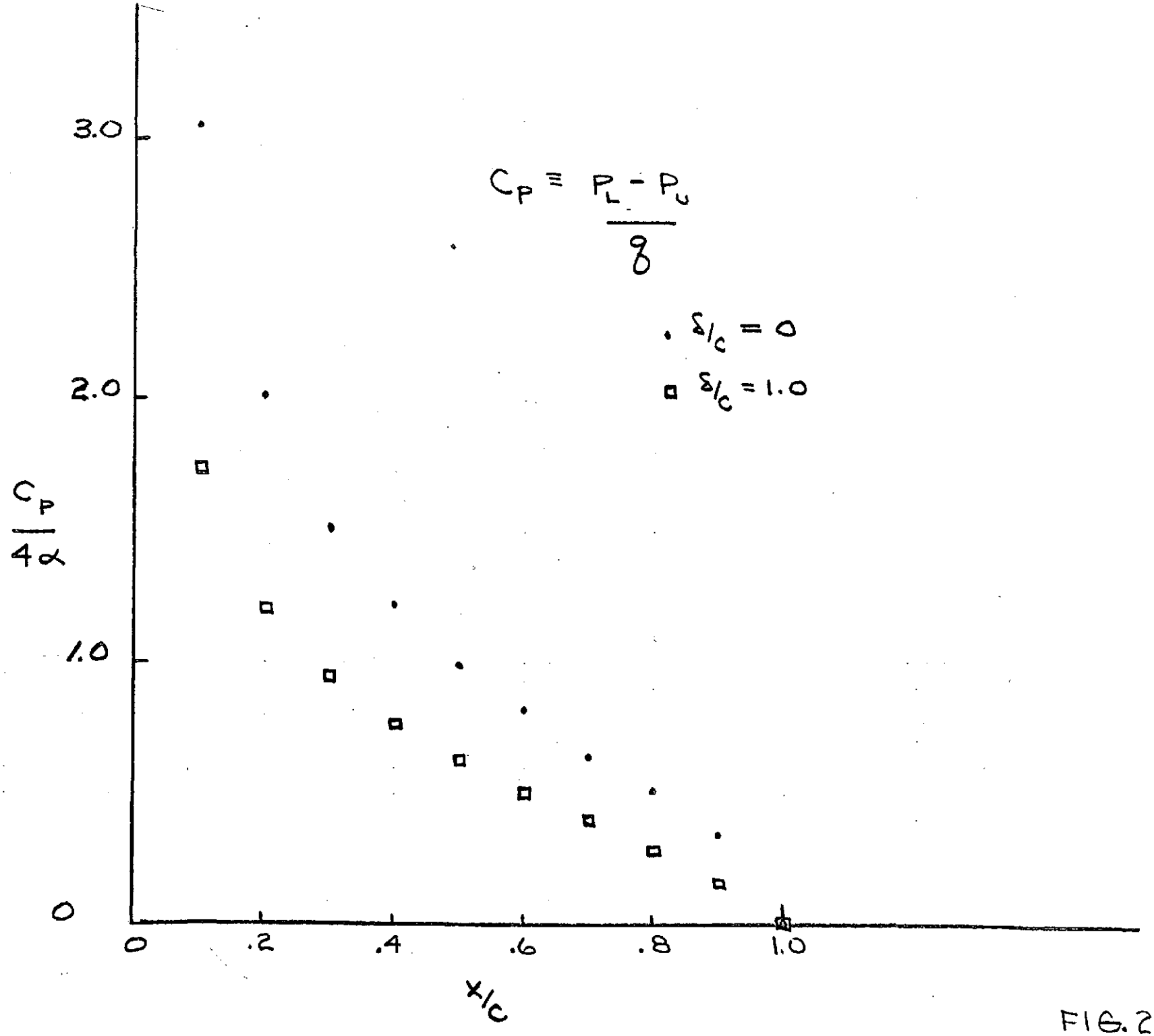

$C_p \equiv \frac{P_L - P_U}{q}$
$\delta/c = 0$
$\delta/c = 1.0$
$\frac{C_p}{4\alpha}$
3.0
2.0
1.0
0
0
.2
.4
.6
.8
1.0
x/c

FIG. 2